DOCUMENT RESUME

ED 135 848 TM 006 078

TITLE	The Objective-Referenced Measure in Mathematics for Delaware Grade Four Students. Final Report.
INSTITUTION	Delaware State Dept. of Public Instruction, Dover. Div. of Research, Planning, and Evaluation.
PUB DATE	Feb 77
NOTE	84p.
EDRS PRICE	MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS	*Criterion Referenced Tests; Diagnostic Tests; Educational Assessment; Educational Objectives; Elementary Education; *Grade 4; *Mathematics; School Districts; *State Programs; *Testing Programs; Test Reliability; *Test Results
IDENTIFIERS	Delaware Educational Accountability System; Delaware Educational Assessment Program

ABSTRACT

Part I of this report attempts to describe the system that was developed for local educational agencies by the Delaware State Department of Public Instruction to support classroom and curricular improvement in mathematics through the administration of an objective-referenced test in mathematics to grade four students. This system includes the development of ancillary services and products to support the use of the testing results. The testing materials and related products are part of the Delaware Educational Accountability System. The state level results are presented in Part II. Included is a description of Delaware mathematics strengths and weaknesses by strand and objective. Specific conclusions and recommendations are presented in Part III. The conclusions and interpretive comments were generated by the members of the Delaware Mathematics Advisory Committee. (Author/RC)

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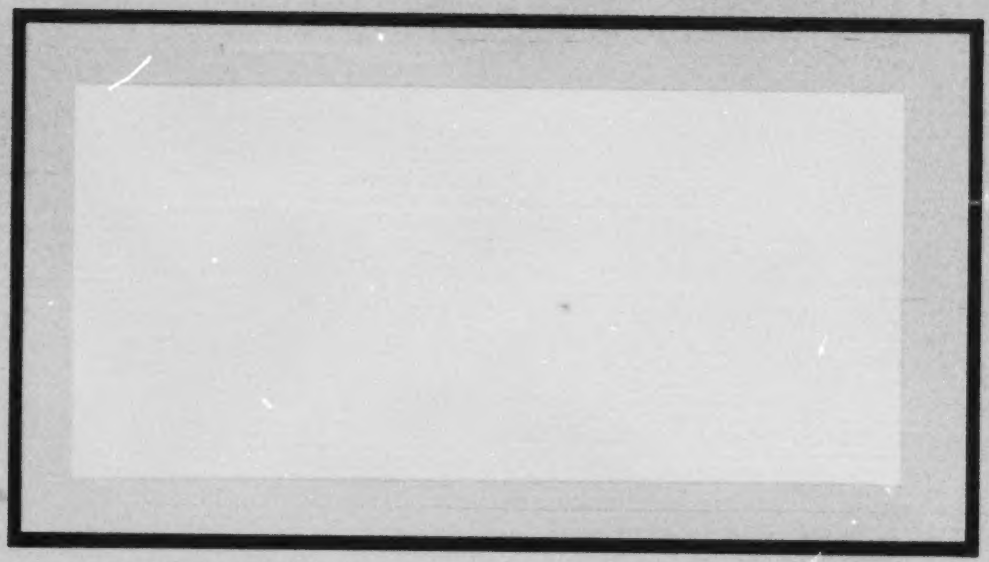

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STATE OF DELAWARE

DEPARTMENT OF PUBLIC INSTRUCTION

DOVER, DELAWARE 19901

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TM006 078

THE OBJECTIVE - REFERENCED MEASURE IN MATHEMATICS FOR DELAWARE GRADE FOUR STUDENTS FINAL REPORT

By Delaware Educational Accountability System Committee of the Planning, Research and Evaluation Division

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February 1977

PREFACE

Part I of this report attempts to describe the system that was developed for local educational agencies by the Delaware Department of Public Instruction to support classroom and curricular improvement in mathematics through the administration of an objective-referenced test in mathematics to grade four students. This system includes the development of ancillary services and products to support the use of the testing results. The testing materials and related products are part of the Delaware Educational Accountability System (DEAS).

The state level results are presented in Part II. Included is a description of Delaware mathematics strengths and weaknesses by strand and objective.

Specific conclusions and recommendations are presented in Part III. The conclusions and interpretive comments were generated by the members of the Delaware Mathematics Advisory Committee.

This report is made possible through the cooperative efforts of the DEAS Committee which is composed of selected staff members from the Planning, Research and Evaluation Division and operates under the administrative guidance of Wilmer E. Wise. Members of the committee include: Robert A. Bigelow, Chester W. Freed, James L. Spartz, Alice Valdes and Janet Wall, who prepared this report.

Wilmer E. Wise, State Director
Planning, Research, and
Evaluation Division

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PART I THE OBJECTIVE - REFERENCED MATHEMATICS TEST AND DELAWARE DEPARTMENT OF PUBLIC INSTRUCTION SUPPORT SERVICES

THE OBJECTIVE - REFERENCED MEASURE IN MATHEMATICS --ITS PLACE IN THE DELAWARE EDUCATIONAL ACCOUNTABILITY SYSTEM

The Delaware Educational Assessment Program (DEAP) is an operating part of the Delaware Educational Accountability System (DEAS) - a long range plan for the improvement of education. This system was designed to provide answers to the following four questions:

* What do we want from our educational system?
* What have we attained?
* What are our program strengths and weaknesses?
* What can be done to improve educational programs?

The first question was answered in part by the development of statewide learner goals and terminal objectives for kindergarten through eighth grade in the areas of reading, language arts, mathematics, science and social studies. In order to monitor the attainment of these student objectives, the DEAP was initiated in 1972. Over the last five years, DEAP batteries of tests have been administered to all regular first, fourth and eighth grade students throughout the state.

The data generated as a result of the DEAP survey tests have provided partial answers to the second major question about student achievement. These answers are incomplete due to the limited number of objectives assessed within each tested content area.

To more completely answer the third major question - the identification of particular strengths and weaknesses within each subject area - student performance must be analyzed by objective. The limited number of items on the current standardized survey provides an incomplete picture of program strengths and weaknesses since not all the DEAS statewide objectives are assessed. What was needed was an in-depth look at each of the basic

skills areas. This could be accomplished by measuring a greater number of objectives in each content area with more test items. Through the use of an expanded objective-referenced instrument that would assess a large number of objectives, a better diagnosis could be made of those specific strengths and weaknesses within a content area.

If information could be made available on a broad scope of specific strengths and weaknesses, more complete information becomes available to help answer the fourth DEAS question (What can be done to improve educational programs?).

For these reasons, an objective-referenced measure (ORM) was developed for statewide administration. Delaware is one of two states known to be utilizing this testing concept on a statewide basis.

The content area of mathematics was selected as an appropriate starting point for the statewide development and use of this ORM for the following reasons:

1. The DEAS objectives are clearly specified in this area.
2. The mathematics objectives provided by the state are utilized by local districts for curricular planning and improvement efforts.
3. The State Department of Public Instruction's new mathematics curriculum guide, *Elements*, contains DEAS objectives specified for each grade level.
4. There seems to be a high degree of consensus among educators of the important objectives to be mastered by elementary students in mathematics.

It is the plan at this time to develop objective - referenced instruments for other content areas and grade levels so that districts may select a test or tests from a bank of available instruments. In addition regular survey tests would be administered every three years to 1) provide for the collection of longitudinal survey data which will give districts benchmarks for observing long-term program changes and 2) allow for the comparison of Delaware's achievement to the nation in several content areas.

DESCRIPTION OF THE TEST

The mathematics instrument is based upon forty of the statewide objectives in mathematics. These objectives are outlined as terminal grade four objectives and are suggested for inclusion in the curriculum in grades two through four.

Three to six items were used to measure student attainment on each objective. These items were selected from a pool of items developed under contract by Educational Testing Service specifically for Delaware's statewide objectives. Related objectives and items are grouped in nine categories called strands.

Both the selection of the objectives and selection of the items were made by the DEAP Mathematics Task Force. The task force is composed of nineteen teachers and administrators from Delaware school districts, higher education institutions, and the Department of Public Instruction who possess exceptional competencies in mathematics education. These people were responsible for ensuring that the test meets school needs and is relevant to instructional programs throughout the state.

The 160 item untimed test was administered to Delaware grade four students during the week of October 18 through 22, 1976. This test was designed for the purpose of (1) providing entry level diagnostic information in mathematics that is student and skill specific and could be used for classroom instructional planning, and (2) furnishing school districts with data that could support curriculum analysis and revision.

Test Characteristics

On the 160 item test, Delaware grade four students answered a high of 153 items and a low of 21 items correctly. The test mean was 90.51 with a standard deviation of 27.03. The test mode or most frequent score was 100.

Using a ten percent sample of the total Delaware grade 4 populations, the reliabilities of the total test and the strand sub-tests were calculated. The reliability was computed using the Kuder-Richardson formula 20. The results presented in Table 1 show the reliability coefficients to lie between 0.483 for Strand G (Graphing and Functions) to 0.887 for Strand C (Operation and Properties). Total test reliability was .962 indicating that the test is a highly reliable measuring instrument.

TABLE 1
RELIABILITY OF TOTAL TEST AND STRANDS

Test Part	Reliability	Number of Items
Total Test	.962	160
Strand A (Numbers and Numerals)	.694	17
Strand B (Numeration)	.788	11
Strand C (Operations and Properties)	.887	40
Strand D (Mathematical Sentences)	.793	14
Strand E (Geometry)	.746	24
Strand F (Measurement)	.768	22
Strand G (Graphing & Functions)	.483	9
Strand H (Probability & Statistics)	.606	6
Strand I (Mathematical Reasoning)	.722	17

DESCRIPTION OF COMPUTER REPORTS

Classroom, school and district level reports were generated and disseminated to districts through a workshop on December 7, 1976. Four types of computer reports were returned to districts. Each of these reports is described below and example reports are presented in Appendicies A through D.

The Classroom Roster

This report is provided for each grade four classroom within a particular school and district. The computer report lists the coding and maximum score for each objective, strand, and the total test. The bulk of the report lists the students' names and the number of items that each student answered correctly on each objective, each strand (math category), and on the total test. A number designation is also listed when appropriate, to identify special education students and irregular or incomplete scores.

The information contained in this report gives teachers an indication of how each of the students in a classroom performed on each of the 40 objectives, each of the 9 strands and on the total test. Using this report teachers can provide instruction or remediation to those students possessing similar skill deficiencies. Enrichment activities can be used for those students performing well on particular objectives.

Distribution of Pupil Scores by Objective Report

This report is provided for each tested classroom, school, and district in Delaware. The Distribution of Pupil Scores by Objective Report lists the objective coding, the maximum score obtainable for each objective and the number of students obtaining the maximum score through the number of students answering zero items correct on a particular objective. More specifically, if an objective is measured by three items, the number of students obtaining three correct, two correct, one correct and zero correct

will be listed. Similar information is provided for each of the forty objectives tested.

Analyzing the results on this report can show educators how groups of students performed on each objective and on which objectives groups achieved best.

The Distribution of Pupil Scores by Strand and Total Score Report

This computer printout provides a distribution of scores on the strand and total score level. For example, strand C (Operations and Properties) is measured by forty items. This report lists the number of students obtaining all 40 correct, 39 correct, 38 correct, 37 correct, ... 1 correct and 0 correct. A similar distribution is also provided for the tested students by total score as well. This report is also furnished for each classroom, school and district tested.

The data provided on this report can be used to show student achievement in general skill areas and on the total test. Strengths and weaknesses on strands can be identified for the purpose of potential curriculum improvement.

The Item Response by Objective Report

This report is generated for each classroom, school, and district tested. The printout provides the codings for items, clustered within objectives and grouped by strands.

The report presents the percentage of students selecting each item option. The correct response is marked with an asterisk (*). In addition, the average percent correct for each objective was calculated and is listed on the report.

The investigation of results on this report can help teachers and administrators identify specific strengths and weaknesses on the 40 objectives assessed. Analysis of the item data can lead to determining what problems

groups of students may be encountering in performing certain calculations and understanding particular concepts.

THE OBJECTIVE - REFERENCED MEASURE IN MATHEMATICS AND ITS USE IN DISTRICT PROBLEM SOLVING

The key to the success of this new Delaware concept in statewide testing hinges upon the extent to which the results are utilized by school personnel for making improvements in the area of mathematics. Two important considerations were utilized by the Delaware Department of Public Instruction to enhance the use of the test data in the educational change process. These are:

1. Incorporating the objective-referenced measure results into the educational improvement process currectly practiced by school staff.

2. Providing support services during each step of the educational change process.

Educators at the district, school and classroom level employ the following sequential steps in inducing educational change and improvement.

* Designating goals and objectives to be attained by the classroom, school or district
* Determining the status of the attainment of these goals and objectives
* Identifying classroom, school and district curriculum weaknesses or needs and
* Using appropriate corrective action procedures to eliminate the weaknesses or needs

The objective-referenced measure problem solving system as a subsystem of the Delaware Educational Accountability System provides state level support services to districts at each of these four steps in the educational improvement model presented above. These state efforts may be described in the following paragraphs.

Setting Goals and Objectives

In June of 1972, the State Board of Education adopted a list of

Delaware goals that were to guide the management of education in the State. These goals subsequently provided the framework for the formulation of learner objectives in the goal area of communications and basic skills. Subject area task forces, coordinated by Department of Public Instruction staff, developed learner objectives in communications, reading, mathematics, science, social studies, and physical and mental health during an intensive three year effort that involved input from all school districts in Delaware. These objectives are periodically reviewed and revised to incorporate changes in curriculum emphasis with the advent of new programs and technological advances influencing education.

The learner objectives have been embodied into the curricula offered to students by Delaware schools and have also acted as the foundation for the development of the Delaware Educational Assessment Program.

Checking Status of Objective Attainment

In order to assist school staff in determining how well they are meeting their objectives in mathematics, the State Department of Public Instruction offered the administration of an objective referenced measure assessing achievement on each of the forty math objectives. The student results on the test presented in the computer printouts and distributed to the appropriate educators are critical to the utilization of a data-based approach in verifying the status of attainment of each mathematics objective.

Identifying Weaknesses or Needs

The DEAS Committee of the Planning Research and Evaluation Division has developed a set of suggested procedures for analyzing the test results found on the computer printouts. These procedures are found in the Interpretation Manual specifically created for the objective-referenced test in mathematics. This manual was designed to (1) foster data based decision-

making by educational practitioners and (2) to encourage districts to apply the test results in the mathematics curriculum analysis process.

The procedures outlined for use by the practitioner help the teachers analyze the data for their class, group students for instruction on objectives not mastered by students, and set prescriptions for those students in need of initial instruction or remediation in a particular skill area.

Additional guidelines are listed in the manual for use by mathematics superivsors and mathematics curriculum committees. These guidelines can supply a district or school with a data-based indication of their areas of curricular strength, need, weakness, and satisfactory performance in mathematics.

To bolster the use of the objective-referenced measure in mathematics, copies of the Interpretation Manual including the suggested report use procedures were distributed to appropriate district and school administrators as well as to all grade 4 teachers in Delaware schools.

Taking Corrective Action

The logical extension of the curriculum improvement process is to employ corrective action procedures in those areas of identified need or weakness. The Department of Public Instruction staff places the greatest emphasis on the importance of this component of the educational improvement plan and thus the greatest amount of support services.

The steps taken by the Delaware Department of Public Instruction to provide input to aid districts in taking corrective action based on the results of the objective-referenced test can be found in the form of technical expertise, curriculum expertise, financial assistance, access to educational information, and specially developed educational products. Each of these services and products feed into the corrective action component and

can cultivate educational improvement within Delaware schools. These can be more specifically described as follows:

1. Technical Expertise. The Planning, Research & Evaluation Division's Delaware Educational Accountability System (DEAS) Committee has research, testing, management, and planning skills needed to advance the use of the computer reports and report use procedures. The DEAS Committee staff have already provided workshops and organizational leadership to several school districts and other target audiences on the mathematics test results. Many more workshops are currently being planned.

2. Curricular Expertise. The Instruction Division staff posess the knowledge of methods, materials, resources, and teaching techniques that can help districts in the planning of instructional strategies to support the mathematics objectives. Instruction Division staff work cooperatively with the staff of the Planning, Research and Evaluation Division in attempting to provide a catalytic environment for educational improvement.

3. Financial Assistance. Each year small grants from state and federal funds are awarded to districts through the Delaware Department of Public Instruction to provide a financial incentive to school districts to utilize the test results. These grants range from $500 to $1500 per district. Each district submits a proposal requesting the allocated funds and outlines the objectives to be accomplished and the procedures to be utilized in their educational improvement efforts. Approximately 80 percent of the $20,000 allocation will be spent on the analysis of the objective-referenced test data for the purpose of alleviating identified weaknesses. Changes that have and will take place through the use of these funds typically bring about improved program articulation, development of district curriculum guides, and the identification and selection of materials and textbooks to support objective-based instructional strategies.

4. Information Services. The Information Search and Retrieval Unit (ISRU) of Project DAIRE*, funded by the National Institute of Education, maintains a comprehensive data base of educational research, products and developments. The ISRU staff makes available to Delaware educators upon request, information that can lead to the solution of an educational problem identified through the objective-referenced test. The available data base can also be accessed to help districts solve many other educational problems.

5. Special Educational Products. Two types of educational products were conceived and produced by the Planning, Research and Evaluation Division specifically to reinforce the use of the statewide mathematics objectives and the accompanying assessment data. These are the Textbook to Objective Correlation and the Mathematics Idea Packs.

a. The Textbook to Objective Correlation. Under contract with Project Primes of West Chester, Pennsylvania, the staff of PR & E compiled an analysis of ten of the most frequently utilized grade four mathematics textbooks in Delaware. The purpose of this analysis was to locate the page numbers within these textbooks that provided instructional ideas, skill building exercises, remedial and review problems, and enrichment activities that related to the forty statewide objectives assessed by the objective-referenced measure in mathematics.

This document has been printed in matrix form correlating the ten textbooks with each objective. The page numbers in each textbook where an objective is treated is listed in the appropriate column.

The document can be used in several ways. The methods of use include helping the teacher to:

(1) Locate remedial exercises for students in need of some extra work on a particular objective.

(2) Identify enrichment activities for those students who may benefit from supplementary work.

(3) Find initial skill building exercises for a class being taught a topic for the first time.

(4) Utilize a multi-textbook approach in the classroom.

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*Delaware Application of Information and Research in Education

(5) Gather new ideas and approaches in the textbook currently in use and in nine other grade four mathematics textbooks.

This document has been distributed to each school principal, each grade four teacher, and appropriate district administrators.

b. Mathematics Idea Packs. Project DAIRE, the Dissemination Unit of the Planning, Research and Evaluation Division has compiled groups of classroom activities that can aid the teacher in instruction. The idea packs are organized by topic and correlated to the statewide mathematics objectives. Each pack was designed to provide the teacher with supplementary activities, games, and teaching techniques that can be used with elementary school children.

Idea packs have been developed for each of the following areas:

(1) Elementary Geometry

(2) Place Value

(3) Metric Measurement

(4) Solving Open Sentences

(5) Graphing

(6) Multiplication

(7) Division

(8) Fractions

(9) Word Problems

These idea packs can be obtained free of charge by contacting the Information Search and Retrieval Unit of Project DAIRE.

PART II
STATE LEVEL RESULTS

STATE LEVEL RESULTS ON THE OBJECTIVE - REFERENCED MATHEMATICS TEST

A total of 6,971 regular Delaware grade 4 public school students and 1,043 non-public school students participated in the mathematics testing program in October of 1976. This section of the report will relate specifically to the results of the public school students. As the test was designed for use in instructional and curriculum planning, no nationally normed items were used on the test. Thus, comparisons of Delaware to the nation cannot be made.

State Level Results by Total Score

On the 160 item test, individual student results ranged from 153 items correct to 21 items correct. Translated into a percent of items obtained correct, the range of scores extends from a high of 96 percent correct to a low of 13 percent correct. The most frequently occurring score on the test was 100 items correct and the mean or average score on the test was 90.50.

Table 2 shows the number and percent of students obtaining scores within each of 16, ten-point score ranges. Each of these score ranges also represents an approximate number of items correct of the total 160 items on the test.

The data indicate that more than 15 percent of the students in Delaware obtained between 76 and 100 percent of the items correct; nearly 48 percent of the grade 4 students answered between 51 and 75 percent of the items correct; approximately 35 percent of the students obtained between 26 and 50 percent of the items correct, and close to 2 percent of the students answered between 0 and 25 percent of the items correctly. It should be noted that no students obtained scores in the two lowest total score groups of the 16 groups generated.

These summary data indicate that Delaware students posess a wide range of competency in the general mathematics area.

TABLE 2
DELAWARE RESULTS BY TOTAL SCORE GROUPINGS

Total Score Range	Approximate Percent of Items Correct	Number of Students	Percent of Students	Score Range Subtotal
160 - 151	100 - 94	11	0.16	
150 - 141	93 - 88	123	1.76	
140 - 131	87 - 82	338	4.85	
130 - 121	81 - 76	601	8.62	15.39
120 - 111	75 - 69	762	10.93	
110 - 101	68 - 63	834	11.96	
100 - 91	62 - 57	888	12.74	
90 - 81	56 - 51	844	12.11	47.74
80 - 71	50 - 44	775	11.12	
70 - 61	43 - 38	652	9.35	
60 - 51	37 - 32	571	8.19	
50 - 41	31 - 26	419	6.01	34.67
40 - 31	25 - 19	141	2.02	
30 - 21	18 - 13	12	0.17	
20 - 11	12 - 7	0	0.00	
10 - 0	6 - 0	0	0.00	2.19

State Level Results by Strand

The 160 items used on the test were grouped in 9 skill areas called strands. Between 6 and 40 items are clustered within each of the 9 categories. Tables 2 through 10 present the distribution of pupil scores for each strand. These tables indicate the number and percent of students obtaining each score from the maximum possible score to zero correct. Each distribution except Strand H which has too few items, is divided in four roughly equal score groupings, from I (the highest) to IV (the lowest). The percent of students in each of the four score grouping is listed. The percents located in each groups are summarized in Table 11. Table 12 presents the average percent correct for each strand for all tested Delaware students.

Strand A - Numbers and Numerals. Test items in this category measure students' basic understanding of the number system including such specific skills of 1) relating fractions to parts of a geometric shape, 2) identifying the attributes of a given set of numbers and objects, 3) identifying even and odd whole numbers, and 4) arranging simple fractions in order.

Approximately 13 percent of Delaware students scored in the highest score group answering between 75 to 100 percent of the items correctly and about nine percent in the lowest score grouping with between 0 and 25 percent of the items correct. The large majority of students (77 percent) answered between 25 and 75 percent of the items correctly. See Table 3-A. As only an average of 52 percent of the grade four students answered items correctly in this category, it appears that Delaware grade four students appear to have difficulty with items measuring these specified skills.

Table 3-B shows how Delaware's grade four students performed on each objective within the Numbers and Numerals strand. Upon examining the state results on each objective within this strand, it appears that the students had a great deal of difficulty with those items requiring students to arrange

TABLE 3-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND A
NUMBERS AND NUMERALS

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	17	38	0.55	
		16	89	1.28	
		15	148	2.12	
		14	262	3.77	
		13	385	5.52	13.24
II	50 - 75	12	588	8.43	
		11	684	9.81	
		10	676	9.70	
		9	798	11.45	39.39
III	25 - 50	8	737	10.57	
		7	745	10.69	
		6	638	9.15	
		5	529	7.59	38.00
IV	0 - 25	4	359	5.15	
		3	185	2.67	
		2	83	1.19	
		1	25	0.36	
		0	0	0.00	9.34

TABLE 3-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND A
NUMBERS AND NUMERALS

Objective Coding	Objective	State Average Percent Correct
A1	Identify a fraction which expresses part of a standard geometric shape to tenths.	60
A2	Identify the common and/or different attributes of a given set.	59
A3	Identify even and odd whole numbers	51
A4	Arrange a set in order of at least three unit fractions.	24

a set in order of three unit fractions. An average of only 24 percent of the students answered items correctly on this objective. Student performance on this objective was so low and contributed to the appearance of poor performance on the total strand when all item results were averaged together.

Within this strand, students performed best on items asking them to relate a fraction to parts of a figure and in the identification of common and different attributes of a given set. Average percent correct results were 60 percent and 59 percent correct respectively on these two skills.

Strand B - Numeration. Test items in this category measure student skills in reading, writing, interpreting and changing form within the number system. More specifically, this category relates to skills needed to determine place value and equating numerical and verbal forms of numbers.

Over 41 percent of Delaware students taking this test obtained scores in the highest score grouping answering between 75 and 100 percent of the items correctly. Thirty-two percent of the students answered between 50 and 75 percent of the items correct. Nearly 21 percent answered between 25 and 50 percent of the items correctly while only five percent were in the lowest score group. See Table 4-A. On the average, 67 percent of the grade four students answered items correctly in this category indicating that in general, Delaware students experience less difficulty with these skills than with any other category tested.

Within this strand students performed best on those items asking them to identify a number in verbal form when given initially in numerical form. They achieved less well on items of the opposite nature, that is identifying the number when given the verbal form of that number. Students did least well on items asking them to interpret place value for whole numbers. Table 4-B compares the results on each of the three objectives.

TABLE 4-A
DISTRIBUTION OF PUPIL SCORES BY STRAND B
NUMERATION

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	11	953	13.67	
		10	998	14.32	
		9	929	13.33	41.33
II	50 - 75	8	890	12.77	
		7	730	10.47	
		6	638	9.15	32.39
III	25 - 50	5	552	7.92	
		4	520	7.46	
		3	382	5.48	20.06
IV	0 - 25	2	228	3.27	
		1	128	1.84	
		0	23	0.33	5.44

TABLE 4-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND B
NUMERATION

Objective Coding	Objective	State Average Percent Correct
B2-A	Identify whole numbers in verbal form when presented with it in numerical form.	74
B2-B	Identify whole numbers in numerical form from a verbal form.	71
B1	Interpret the place value for whole numbers of up to five digits.	61

Strand C - Operations and Properties. This category contains items which measure the students ability to add, subtract, multiply and divide. The items not only determine student computational abilities with whole numbers, but also with simple fractions and mathematical symbols.

Table 5-A shows that approximately 65 percent of Delaware students answered between 50 and 100 percent of the items correctly. About 31 percent obtained between 25 and 50 percent correct while less than 4 percent were in the lowest score grouping. On the average statewide, 60 percent of the students answered items correctly that relate to this mathematics category. Compared to other strands students perform well on these skills.

Within this strand students tended to perform best on those skills relating to 1) comparing the relative value of groups of coins, 2) adding whole numbers, and 3) recognizing and using the commutative property of addition and multiplication of whole numbers. The statewide average obtained ranged from 72 to 81 percent correct on these skills.

Poorest performance was obtained on items asking students to 1) recognize and use the associative property of addition and multiplication with whole numbers, 2) divide with a one digit divisor and up to a three digit dividend, and 3) add and subtract with a pair of like fractions. On this last skill an average of 26 percent of the students answered items correctly. Table 5-B shows the relative performance on each of these objectives.

Strand D - Mathematical Sentences. The items within this category measure the student's ability to translate a verbal idea or physical situation into a mathematical expression in order to arrive at a solution.

Nearly 72 percent of the students tested were able to answer between 50 and 100 percent of the items correctly on this strand. Approximately 25 percent of the students obtained between 25 and 50 percent of the items correct and between three and four percent achieved between zero and 25

TABLE 5-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND C
OPERATIONS AND PROPERTIES

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	40	22	0.32	
		39	52	0.75	
		38	85	1.22	
		37	96	1.38	
		36	164	2.35	
		35	202	2.90	
		34	236	3.39	
		33	244	3.50	
		32	274	3.93	
		31	256	3.67	23.41
II	50 - 75	30	295	4.23	
		29	264	3.79	
		28	293	4.20	
		27	271	3.89	
		26	318	4.56	
		25	280	4.01	
		24	292	4.19	
		23	285	4.09	
		22	307	4.40	
		21	297	4.26	41.62
III	25 - 50	20	273	3.92	
		19	296	4.25	
		18	232	3.33	
		17	241	3.46	
		16	246	3.53	
		15	246	3.53	

TABLE 5-A (CONTINUED)

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
		14	185	2.65	
		13	171	2.45	
		12	171	2.45	
		11	120	1.72	31.29
IV	0 - 25	10	85	1.21	
		9	78	1.12	
		8	41	0.59	
		7	34	0.49	
		6	12	0.17	
		5	6	0.09	
		4	1	0.01	
		3	0	0.00	
		2	0	0.00	
		1	0	0.00	
		0	0	0.00	3.68

TABLE 5-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND C
OPERATIONS AND PROPERTIES

Objective Coding	Objective	State Average Percent Correct
C4	Identify one collection of coins as >, <, or = value of another collection of coins (limit $2).	81
C1-A	Compute sums of given whole numbers up to five digits with and without regrouping.	79
C6	Recognize and use the commutative property of addition and multiplication with whole numbers.	72
C10-A	State and write multiplication facts up to ten with whole numbers.	63
C1-B	Compute differences of given whole numbers up to five digits with and without regrouping.	58
C2	Multiply whole numbers up to a three digit factor by a one digit factor.	58
C10-B	State and write division facts up to ten with whole numbers.	55
C5	Recognize and use the associative property of addition and multiplication with whole numbers.	45
C3	Divide whole numbers with a one digit divisor up to three digit dividends. (With no remainder).	43
C9	Add and subtract a pair of like fractions.	26

percent of the items correct. See Table 6-A. With respect to results on other strands, Delaware students performed comparatively well on this strand with 62 percent on the average obtaining each item correct.

Of the three objectives tested within this strand, students achieved best on those items requiring the ability to solve open sentences. On the average, 71 percent of Delaware's grade four students answered the items correctly on this objective. Students performed least well on the related skill of constructing an open sentence from a verbal situation. This may indicate that they find difficulty in applying the skill of solving open sentences to real life situations. An average of 54 percent of the students answered items of this nature correctly. Table 6-B presents the rank order of the objectives within this strand by state average percent correct.

Strand E - Geometry. This category contains items that measure a student's ability to identify and classify one and two dimensional figures and to solve computational problems based on the measures of these figures. Specific skills include the identification of lines, points, and angles; finding the perimeter of polygons; approximating areas of polygons; and identifying types of triangles.

Roughly eight percent of the Delaware grade four students correctly answered between 75 and 100 percent of the items with approximately seven percent in the lowest score grouping. The majority of the students (85 percent) obtained between 25 and 75 percent of the items correct on this strand. See Table 7-A. On the average 54 percent of the students answered items correctly in this category indicating average performance on this strand in comparison to other strands tested.

Upon examining the specific objectives tested within this strand, students performed comparatively well on items asking them to identify lines of symmetry in simple geometrical figures as nearly 75 percent of the students tested answered these items correctly. About 67 percent of the students

TABLE 6-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND D
MATHEMATICAL SENTENCES

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	14	372	5.34	
		13	602	8.64	
		12	681	9.77	
		11	677	9.71	33.46
II	50 - 75	10	694	9.96	
		9	709	10.17	
		8	660	9.47	
		7	609	8.71	38.31
III	25 - 50	6	581	8.33	
		5	482	6.91	
		4	376	5.39	
		3	278	3.99	24.62
IV	0 - 25	2	160	2.30	
		1	73	1.05	
		0	17	0.24	3.59

TABLE 6-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND D
MATHEMATICAL SENTENCES

Objective Coding	Objective	State Average Percent Correct
D1	Solve simple open sentences using whole numbers.	71
D3	Identify the correct relations symbol (>, <, =).	56
D2	Construct open sentences to use in solving given story problems.	54

TABLE 7-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND E
GEOMETRY

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	24	2	0.03	
		23	28	0.40	
		22	48	0.69	
		21	86	1.23	
		20	158	2.27	
		19	251	3.60	8.22
II	50 - 75	18	337	4.83	
		17	439	6.30	
		16	548	7.86	
		15	647	9.28	
		14	695	9.97	
		13	690	9.90	48.14
III	25 - 50	12	608	8.72	
		11	560	8.03	
		10	482	6.91	
		9	367	5.26	
		8	309	4.43	
		7	238	3.41	36.78
IV	0 - 25	6	170	2.44	
		5	143	2.05	
		4	102	1.46	
		3	49	0.70	
		2	11	0.16	
		1	3	0.04	
		0	0	0.00	6.85

correctly answered those items asking them to calculate the distance around simple figures. On items requiring students to identify and lable three and four sided figures, 60 percent were able to answer items correctly. Within this objective, 81 percent of the students could not select the angle which could be part of a right triangle. Students tended to perform substantially better on items requiring knowledge of four sided figures.

It is interesting to note that students performed least well on items asking them to estimate the areas of regular and irregular figures using a square grid. Approximately 38 percent of the students answered items correctly on the objective relating to the area of regular figures while only 35 percent were able to correctly answer items dealing with irregular figures. Table 7-B compares the relative performance on each objective.

Strand F - Measurement. Test items in this category relate to the students ability to recognize the need for a measure, choose the most appropriate measure, select the most appropriate instrument of measurement, and measure an object to the nearest unit. Stress was placed on measurement in the metric system though items were not confined to this measurement system.

About 18 percent of the students obtained between 75 and 100 percent of the items correct on the skills measured within this strand. Only 3 percent correctly answered between 0 and 25 percent of the items. The vast majority (nearly 79 percent) answered between 25 and 75 percent of the items correctly. See Table 8-A. As an average of 55 percent of the students answered items correctly in this strand, it appears that compared to results of other strands, students performed in an average manner on the skills assessed in this category.

Students performed compartively well on items asking them to measure an object in the metric system as approximately 75 percent of the

TABLE 7-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND E
GEOMETRY

Objective Coding	Objective	State Average Percent Correct
E5	Identify lines of symmetry in geometrical figures.	78
E2	Determine the perimeter of polygons using whole numbers.	67
E6	Identify types of triangles and quadrilaterals from models or illustrations. (Limited to right triangles, squares, rectangles from pictures).	60
E1	Identify and name basic geometric figures such as point, line, line segment, ray, angles, congruent fingures, etc.	56
E7	Identify parallel and intersecting lines in a plane. (Informal experiment; realistic situation).	41
E3	Determine the area of rectangles using whole numbers. (Using whole numbers and square grid).	38
E8	Approximate the area of simple irregular shapes.	35

TABLE 8-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND F
MEASUREMENT

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	22	17	0.24	
		21	69	0.99	
		20	130	1.86	
		19	229	3.29	
		18	348	4.99	
		17	469	6.73	18.10
II	50 - 75	16	508	7.29	
		15	534	7.66	
		14	572	8.21	
		13	549	7.88	
		12	502	7.20	
		11	518	7.43	45.66
III	25 - 50	10	491	7.04	
		9	453	6.50	
		8	460	6.60	
		7	373	5.35	
		6	291	4.17	
		5	226	3.24	32.91
IV	0 - 25	4	140	2.01	
		3	66	0.95	
		2	21	0.30	
		1	5	0.07	
		0	0	0.00	3.33

grade 4 students could answer items correctly on this skill. Nearly 60 percent of the students could correctly answer items asking them to tell time to the nearest minute. Students tended to do better on items relating to half and quarter hours and least well on items relating to minutes.

Within this strand, poorest performance was obtained on the skills of converting from one unit to another within the same system and in selecting the proper unit of measure for determining length, weight, volume and temperature. See Table 8-B.

Strand G - Graphing and Functions. The items within this category measure students' abilities in associating rational numbers with points in one and two dimensions.

As only an average of 51 percent of Delaware's grade four students answered items correctly in this strand, it seems that Delaware students experience difficulty in this skill area. Approximately 16 percent of the students correctly answered between 75 and 100 percent of the items. Nearly 35 percent correctly obtained between 50 and 75 percent of the items with an equal percent of the students achieving between 25 and 50 percent correct. About 14 percent correctly answered less than 25 percent of the items. See Table 9-A.

Within this strand students achieved best on items requiring them to relate positive and negative numbers to realistic situations. Comparative difficulty was experienced by students in relating an ordered pair of numbers to a point or a graph. Table 9-B shows the average percent correct comparisons on each of the three objectives tested.

Strand H - Probability and Statistics. Test items within this category measure the ability of a student to organize, represent, and interpret data derived from real and experimental situations.

TABLE 8-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND F
MEASUREMENT

Objective Coding	OBJECTIVE	State Average Percent Correct
F1-B	Determine length in the metric system.	77
F6	Tell time to the nearest minute.	59
F3	Identify the change in coins which would be received in making purchases with values up to $1.	54
F2	Convert a simple measure in one unit to a measure in another unit within the same system. (Metric plus other units - like 7 days = 1 week).	49
F1-A	Identify standard metric measures used to measure length, mass (weight), capacity (volume) and temperature.	47

TABLE 9-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND G
GRAPHING & FUNCTIONS

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	9	88	1.26	
		8	330	4.73	
		7	693	9.94	15.94
II	50 - 75	6	1066	15.29	
		5	1338	19.19	34.49
III	25 - 50	4	1334	19.14	
		3	1134	16.27	35.40
IV	0 - 25	2	665	9.54	
		1	264	3.79	
		0	59	0.85	14.17

38

TABLE 9-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND G
GRAPHING & FUNCTIONS

Objective Coding	Objective	State Average Percent Correct
G1	Relate positive and negative numbers to realistic situations.	67
G3	Given the point in the plane, identify the ordered pair.	57
G2	Given the ordered pair, identify the point in the plane.	49

Too few items were utilized to divide this strand into four score groupings, however, approximately 57 percent of the students tested were able to answer items correctly on this strand. In comparison to results on the other strands students appear to have performed in an average manner in this skill area. See Table 10 for a distribution of pupil scores within this strand.

Through an analysis of the items it appears that students can make simple interpretations of bar graphs better than line graphs. When asked to use a graph to calculate a new set on information student scores tended to drop.

Strand I - Mathematical Reasoning. The items in this category measure a student's ability to round numbers, estimate solutions to mathematical problems, and read, interpret and find the solutions for a wide variety of word and picture problems.

Nearly 15 percent of the students tested obtained between 75 and 100 percent of the items correct. About 37 percent correctly answered between 50 and 75 percent of the items correct with approximately the same amount of students in the 25 to 50 percent correct range. Only 11 percent of the students tested achieved scores in the lowest score grouping. See Table 11-A. An average of 51 percent of the students answered items correctly in this strand indicating that students have found the skills within this strand to be comparatively difficult.

An examination of student performance on each objective grouped in this strand shows that the best performance in this category was obtained in the skill area of finding solutions to word and picture problems. Approximately 65 percent of the students answered items correctly on this objective. Results on all other objectives were an average of 20 percentage points below this objective. See Table 11-B.

TABLE 10
DISTRIBUTION OF PUPIL SCORES FOR STRAND H
PROBABILITY & STATISTICS

Number of Items Correct	Student Frequency	Percent of Students
6	748	10.73
5	1188	17.04
4	1396	20.03
3	1467	21.04
2	1249	17.92
1	701	10.06
0	222	3.18

TABLE 11-A
DISTRIBUTION OF PUPIL SCORES FOR STRAND I
MATHEMATICAL REASONING

Score Grouping	Approximate Percent of Items Correct	Number of Items Correct	Student Frequency	Percent of Students	Percent in Score Group
I	75 - 100	17	30	0.43	
		16	92	1.32	
		15	201	2.88	
		14	277	3.97	
		13	418	6.00	14.60
II	50 - 75	12	534	7.66	
		11	650	9.32	
		10	692	9.93	
		9	736	10.56	37.47
III	25 - 50	8	726	10.41	
		7	685	9.83	
		6	634	9.09	
		5	512	7.34	36.68
IV	0 - 25	4	383	5.49	
		3	244	3.50	
		2	125	1.79	
		1	30	0.43	
		0	2	0.03	11.25

TABLE 11-B
RANK ORDER OF OBJECTIVES BY AVERAGE PERCENT CORRECT FOR STRAND I
MATHEMATICAL REASONING

Objective Coding	Objective	State Average Percent Correct
I2	Read, interpret, and find solutions for word/picture problems.	65
I4	Solve a mathematical sentence or simplify a mathematical expression to determine the order of numbers.	46
I3	Round off whole numbers to nearest ten's, hundred's, or thousand's.	45
I1	Estimate solutions in problem solving situations.	42

TABLE 12
PERCENT OF DELAWARE STUDENTS IN EACH SCORE GROUP BY STRAND
SUMMARY

Score Group	Approximate Percent of Items Correct	A Numbers & Numerals	B Numeration	C Operations & Properties	D Mathematical Sentences	E Geometry	F Measurement	G Graphing & Functions	I Mathematical Reasoning
I	75 - 100	13.24	41.33	23.41	33.46	8.22	18.10	15.94	14.60
II	50 - 75	39.39	32.39	41.62	38.31	48.14	45.66	34.49	37.47
III	25 - 50	38.00	20.86	31.29	24.62	36.78	32.91	35.40	36.68
IV	0 - 25	9.34	5.44	3.68	3.59	6.85	3.33	14.17	11.25

TABLE 13
DELAWARE AVERAGE PERCENT CORRECT BY STRAND

	Strand Name	Number of Items	Average Percent Correct
A	Numbers and Numerals	17	52
B	Numeration	11	67
C	Operations & Properties	40	60
D	Mathematical Sentences	14	62
E	Geometry	24	54
F	Measurement	22	55
G	Graphing and Functions	9	51
H	Probability and Statistics	6	57
I	Mathematical Reasoning	17	51

State Level Results by Objective

Forty of the statewide objectives were assessed on the mathematics instrument. Results by objective show a wide range of student achievement across the forty objectives.

Table 14 presents each of the objectives rank ordered from the highest to the lowest according to the actual state average percent correct on each objective.

Delaware Strengths and Weaknesses in Mathematics

In attempting to identify those areas in which Delaware grade four students performed well and those areas in which they performed poorly, the mean of the average percent correct obtained on each objective was calculated. Those objectives where average percent correct results were more than 20 percentage points (approximately 1.5 standard deviation units) above or below the mean were considered to be strengths or weaknesses respectively.

Based on the objective referenced test in mathematics administered last October to grade 4 students, Delaware's strongest specific mathematics skills seem to include:

* The identification of one collection of coins as >, <, or = the value of another collection of coins.
* The computation of sums of given whole numbers up to five digits with and without regrouping.
* The identification of lines of symmetry in geometrical figures.
* The determination of length in the metric system.

Using the criterion outlined above the weakest mathematics skills appear to include:

* Arranging a set in order of at least three unit fractions.
* Adding and subtracting a pair of like fractions.
* Approximating the area of simple irregular shapes using a square grid.

TABLE 14
DELAWARE MATHEMATICS OBJECTIVES
RANK ORDERED BY STATE AVERAGE PERCENT CORRECT

Objective Coding	Objective	Average Percent Correct
C4	Identify one collection of coins as >, <, or = value of another collection of coins (limit $2).	81
C1-A	Compute sums of given whole numbers up to five digits with and without regrouping.	79
E5	Identify lines of symmetry in geometrical figures.	78
F1-B	Determine length in the metric system.	77
B2-A	Identify whole numbers in verbal form when presented with it in numerical form.	74
C6	Recognize and use the commutative property of addition and multiplication with whole numbers.	72
D1	Solve simple open sentences using whole numbers.	71
B2-B	Identify whole numbers in numerical form from a verbal form.	71
E2	Determine the perimeter of polygons using whole numbers.	67
G1	Relate positive and negative numbers to realistic situations.	67
I2	Read, interpret, and find solutions for word/picture problems.	65
C10-A	State and write multiplication facts up to ten with whole numbers.	63
B1	Interpret the place value for whole numbers of up to five digits.	61
A1	Identify a fraction which expresses part of a standard geometric shape to tenths.	60
E6	Identify types of triangles and quadrilaterals from models or illustrations. (Limited to right triangles, squares, rectangles from pictures).	60
F6	Tell time to the nearest minute.	59
A2	Identify the common and/or different attributes of a given set.	59

TABLE 14 (CONTINUED)

Objective Coding	Objective	Average Percent Correct
C2	Multiply whole numbers up to a three digit factor by a one digit factor.	58
C1-B	Compute differences of given whole numbers up to five digits with and without regrouping.	58
H1	Construct and interpret bar and line graphs.	57
D3	Identify the correct relations symbol (>, <, =).	56
E1	Identify and name basic geometric figures such as point, line, line segment, ray, angles, congruent figures, etc.	56
C10-B	State and write division facts up to ten with whole numbers.	55
D2	Construct open sentences to use in solving given story problems.	54
F3	Identify the change in coins which would be received in making purchases with values up to $1.	54
A3	Identify even and odd whole numbers.	51
G2	Given the ordered pair, identify the point in the plane.	49
F2	Convert a simple measure in one unit to a measure in another unit within the same system. (Metric plus other units - like 7 days = 1 week).	49
F1-A	Identify standard metric measures used to measure length, mass (weight), capacity (volume) and temperature.	47
C5	Recognize and use the associative property of addition and multiplication with whole numbers.	45
I4	Solve a mathematical sentence or simplify a mathematical expression to determine the order of numbers.	45
I3	Round off whole numbers to nearest ten's, hundred's, or thousand's.	45
C3	Divide whole numbers with a one digit divisor up to three digit dividends. (With no remainder)	43
I1	Estimate solutions in problem solving situations.	42

TABLE 14 (CONTINUED)

Objective Coding	Objective	Average Percent Correct
E7	Identify parallel and intersecting lines in a plane. (Informal experiment; realistic situation).	41
E3	Determine the area of rectangles using whole numbers. (Using whole numbers and square grid).	38
G3	Given the point in the plane, identify the ordered pair.	37
E8	Approximate the area of simple irregular shapes. (Using square grid).	35
C9	Add and subtract a pair of like fractions.	26
A4	Arrange a set in order of at least three unit fractions.	24

PART III

INTERPRETIVE COMMENTS OF RESULTS BY THE DELAWARE MATHEMATICS ADVISORY COMMITTEE

RECOMMENDATIONS

INTERPRETIVE COMMENTS BY THE DELAWARE MATHEMATICS ADVISORY COMMITTEE

The objective - referenced measure in mathematics was based upon terminal statewide objectives for grades two through four. That is, it was expected that each Delaware student would be able to perform well on each of the objectives by the end of the instructional program at grade four. The results of this testing program indicate how students were performing in October at the beginning of grade four. This approach provides the teachers with excellent entry level information for the purpose of planning instruction more effectively and efficiently, but makes interpretation difficult at the state level. For this reason the Delaware Mathematics Advisory Committee was asked to analyze the statewide results by objective considering the grade levels at which the objectives are usually taught. Their comments, by strand, comprise the remainder of this section.

Strand A - Numbers and Numerals

In general, the committee felt that grade four students performed in a satisfactory manner on the four objectives tested within this strand despite the fact that the state average for two objectives was near or below 50 percent correct.

On a statewide basis only 24 percent of the students were able to arrange in order a set of three unit fractions. However, this objective is generally not taught prior to the testing date hence students would not be expected to master these skills until the end of grade four. In a few instructional programs throughout the state this objective may be emphasized at the fifth or sixth grade levels particularly for lower ability students. It is therefore surprising that 24% of the students were able to perform well on these items when so

little instructional effort is typically directed toward ordering fractions prior to grade four.

Only 51 percent of the students were able to identify even and odd whole numbers. Since development of this concept generally begins before grade four fifty-one percent correct is considered low and performance on this objective may be considered a weakness.

Strand B - Numeration

Delaware students performed well on the three objectives tested within this strand. They performed particularly well on the two objectives that required equating verbal and numerical forms of whole numbers. Regarding the remaining objective, requiring interpretation of place value for whole numbers of up to five digits, entering grade four students performed exceptionally well as this tends to be a difficult concept for many students to comprehend at even higher grade levels.

Strand C - Operations and Properties

Students generally performed in a satisfactory manner on the ten objectives within this strand. Nearly 80 percent of Delaware grade four students were able to complete successfully problems of addition, however, concern was expressed by the committee regarding the remaining 20 percent of the students who appear to need remedial work on this skill. Substantially poorer performance was evident on the objective dealing with subtraction skills. It was felt by the committee that the grade four instructional program needs to emphasize the skills needed in subtraction.

Considering the difficulty of the mathematics operations of multiplication and division, results indicate that on a statewide basis students performed in a satisfactory manner. A particular weakness was detected on those items where students were asked to multiply by zero.

The majority of students (81 percent) were able to determine the relative value of sets of coins, but the advisory committee felt that the

remaining 19 percent who did not perform well on these items needed to be identified and provided with remediation since the concept would not likely be formally taught beyond the second grade.

The committee also felt that there was a general weakness exhibited by the grade four students in stating and writing multiplication and division facts up to ten with whole numbers. Although more than half of the students were able to answer items correctly on these skills, the remaining group represents too a large a percentage in view of the dependence of more advanced skills on these elementary skills.

Strand D - Mathematical Sentences

Delaware students were judged to have performed in a satisfactory manner on the three objectives tested within this strand. It appears that difficulty was experienced by students when they were asked to translate a verbal situation into a mathematical expression. Where students were given the mathematical expression, however, they were able to solve the problem. This is not uncommon even for students at higher grade levels hence does not represent a weakness.

Strand E - Geometry

The committee determined that satisfactory performance was obtained on five of the seven objectives within this strand. On the remaining two objectives state results were low. Nonetheless, the advisory committee felt that Delaware students performed particularly well on those objectives dealing with the area of simple regular and irregular shapes, since concept of area is difficult for many students even at higher grade levels.

Strand F - Measurement

In general, performance on the five objectives tested in this strand was low. Students performed well on items asking them to tell time to the nearest quarter and half hour, but the committee detected a weakness where students were asked to tell time to the nearest minute. The committee suggested

that more instructional emphasis needs to be placed on the interpretation of the minute hand.

Students did not perform well in identifying the metric measure to be used for determing length, weight, capacity and temperature. The committee felt that this probably was due to the fact that instructional programs using the metric system were not fully implemented on a statewide basis. The committee expressed a belief that performance on these items will increase over the next few years.

A concern was expressed by the committee members regarding those items asking students to determine the amount of change a person would receive when making a purchase up to $1. More instructional effort should be given to this functional competency.

Strand G - Graphing and Functions

Delaware students were judged to have performed well on items asking them to relate positive and negative numbers to real life situations. The committee felt that the relatively low performance on items that dealt with relating points on a graph to an ordered pair of numbers represented satisfactory performance since students at levels above grade four will continue to practice skills of this nature in mathematics and science. The level of understanding of these skills demonstrated by grade four students does not represent an area of concern.

Strand H - Probability and Statistics

Members of the committee felt that the students at grade four showed satisfactory performance on the objective tested in this strand. They indicated that the skill of interpreting bar and line graphs should continue to be taught at higher grade levels as this skill was important for all persons to understand as adults.

Strand I - Mathematical Reasoning

Considering that items within this strand are generally difficult for

grade four students, the students performed well on these skills. Committee members indicated that additional practice should be provided for students in the estimation of problem solutions and in rounding numbers. Since several items required the reading of a problem and then finding the solution, low correct responses on these items may indicate careless reading or poor verbal comprehension.

RECOMMENDATIONS

As a result of the data presented in this report and the interpretive comments of the Delaware Mathematics Advisory Committee the following courses of action are suggested in an attempt to improve mathematics instruction in Delaware schools

* Elementary teachers should continue to utilize the objective and student specific results for the planning of the mathematics instructional program during grade four.

* Local districts should perform needs assessments based upon the results of the objective - referenced measure in mathematics. Corrective action procedures should be implemented to alleviate the identified weaknesses.

* Consideration should be given to using federal Title I funds at the school level to improve the skills of educationally disadvantaged children on those objectives where student performance is not satisfactory.

* Local districts should consider the adoption of federally validated projects designed to improve basic skills in mathematics.

* Funding at the state level should be continued to provide support for DEAS activities. Additional funds should be allocated for the expansion of the objective - referenced testing program to other content areas and other grade levels.

* Districts should utilize the services of Project DAIRE - the Delaware Application of Information and Research in Education - to locate appropriate information for implementing corrective action activities based upon needs identified through the objective - referenced test.

* Instruction and Planning, Research and Evaluation staff of the Department of Public Instruction should increase their efforts in providing leadership and technical assistance to schools in areas of needs assessment and corrective action planning.

* Increased utilization should be made of the remedial mathematics exercises provided through the district computer terminals funded by the Computer Assisted Instruction Project for Exceptional Children. These remedial activities should be directed toward the alleviation of the specific student weaknesses identified through the objective - referenced measure in mathematics.

* The Department of Public Instruction and the University of Delaware should expand their cooperative efforts in developing and implementing inservice, graduate programs for teachers that are geared toward data based district needs located through inspection of the results on the objective - referenced measure.

CLASSROOM ROSTER

1976 DELAWARE EDUCATIONAL ASSESSMENT PROGRAM

GRADE 4 MATHEMATICS

Waredel School District — Southeast Elementary — CLASSROOM NUMBER 01

OBJECTIVE/STRAND	A 1	A 2	A 3	A 4	B 1	B 2 A	B 2 B	C 1 A	C 1 B	C 2	C 3	C 4	C 5	C 6	C 9	C 10 A	C 10 B	D 1	D 2	D 3	E 1	E 2	E 3	E 5	E 6	E 7	E 8	F 1 A	F 1 B	F 2	F 3	F 6	G 1	G 2	G 3	H 1	I 1	I 2	I 3	I 4	A	B	C	D	E	F	G	H	I	TOT
MAXIMUM SCORE	5	0	3	3	5	3	3	6	6	3	4	4	3	5	3	4	4	0	5	3	0	5	3	3	5	3	3	4	3	3	6	5	4	3	3	3	6	5	6	3	3	17	11	40	14	24	22	9	6	17	160
STUDENT NAME •																																																			
Student 1	4	0	1	0	5	3	3	6	4	3	3	4	2	3	0	4	2	4	5	2	2	2	2	3	2	0	2	2	3	2	5	3	3	3	3	3	5	2	2	11	11	31	11	13	15	09	05	12	118
Student 2	1	4	2	1	4	2	3	5	6	2	1	4	3	2	1	4	0	4	4	2	3	2	2	2	2	1	0	1	2	5	2	2	1	0	0	3	2	3	1	3	08	09	28	10	12	12	01	03	09	092
Student 3	3	4	1	0	2	2	1	1	2	0	1	4	0	2	2	3	2	6	1	1	2	2	1	3	2	1	3	0	3	3	0	2	0	0	1	5	2	2	0	0	06	05	17	08	14	08	01	05	04	070
Student 4	1	3	1	1	1	3	1	6	4	3	1	4	2	3	0	3	4	6	5	1	0	0	0	3	1	1	0	4	2	1	3	1	3	2	1	6	1	4	1	2	06	05	30	12	11	11	06	06	08	095
Student 5	5	0	2	3	5	2	3	4	6	2	3	4	3	3	0	4	4	0	4	2	0	3	2	3	2	1	0	3	2	4	3	4	3	2	1	4	5	4	2	3	16	10	33	12	17	16	06	04	14	128
Student 6	1	3	0	1	4	1	1	6	4	0	1	3	2	3	1	1	2	4	2	3	0	2	1	3	1	2	0	1	2	0	3	1	2	3	1	2	0	0	2	2	05	06	23	09	09	07	06	02	04	071
Student 7	1	4	1	0	1	2	2	5	4	3	1	4	2	1	1	4	4	4	0	1	5	2	1	3	2	2	1	3	2	2	3	2	2	2	0	2	3	4	1	3	06	05	29	05	16	12	04	02	11	090
Student 8	3	3	0	0	1	3	2	4	3	3	1	2	1	2	0	2	3	5	2	1	3	1	0	2	2	0	1	1	2	4	0	1	1	3	1	3	3	3	1	0	06	06	21	08	09	08	05	03	07	073
Student 9	3	4	2	3	3	0	2	5	2	2	2	4	1	2	2	3	3	6	2	1	3	0	3	3	2	1	2	2	3	2	2	1	3	2	1	3	1	2	2	2	12	05	26	09	14	10	06	03	07	092
Student 10	2	2	0	0	1	0	0	0	2	0	1	0	3	1	1	0	2	2	1	2	0	1	0	0	1	1	1	0	1	2	0	2	2	0	2	1	2	0	2	1	03	00	12	03	04	07	03	02	04	038
Student 11	1	0	2	0	2	1	0	0	2	1	0	1	0	2	0	0	2	1	2	1	2	3	1	0	1	1	1	1	1	0	0	1	0	2	1	2	0	0	3	1	0	04	01	09	05	08	02	05	00	04	038

TOTAL NUMBER IN CLASS = 11

• 1 = SPEC EDUC 2 = INNED 3 = INCOMPLETE 4 = 1 AND 2 5 = 1 AND 3 6 = 2 AND 3 7 = 1 2 AND 3

77

78

APPENDIX A

DISTRIBUTION OF PUPIL SCORES

BY OBJECTIVE

1976 DELAWARE EDUCATIONAL ASSESSMENT PROGRAM

GRADE 4 MATHEMATICS

(Waredel School District — Southeast Elementary — CLASSROOM NUMBER 01 — N = 22

OBJECTIVE	MAX SCORE	—FREQUENCY OF SCORE— (0)	(1)	(2)	(3)	(4)	(5)	(6)
A1	3	1	5	0	4	7	5	0
A3	3	3	6	8	5	0	0	0
B1	5	0	3	3	2	4	10	0
B2-B	3	0	5	8	9	0	0	0
C1-B	6	0	1	4	3	6	2	6
C3	4	1	7	5	5	4	0	0
C5	3	1	5	11	5	0	0	0
C9	3	9	8	2	3	0	0	0
C10-B	4	1	4	6	5	6	0	0
D2	5	1	3	4	5	5	4	0
F1	6	1	0	3	7	4	2	5
F3	3	3	8	7	4	0	0	0
F6	3	0	5	14	3	0	0	0
F8	3	5	8	5	4	0	0	0
F1-B	3	0	2	8	12	0	0	0
F3	5	2	2	3	5	5	5	0
G1	3	4	3	4	11	0	0	0
G3	3	5	10	5	2	0	0	0
I1	5	2	5	5	8	1	1	0
I3	3	3	9	8	2	0	0	0

OBJECTIVE	MAX SCORE	—FREQUENCY OF SCORE— (0)	(1)	(2)	(3)	(4)	(5)	(6)
A2	6	0	1	1	3	8	4	5
A4	3	9	6	3	4	0	0	0
B2-A	3	3	1	7	11	0	0	0
C1-A	6	0	2	1	0	4	7	8
C2	3	2	3	5	12	0	0	0
C4	4	0	0	2	4	16	0	0
C6	3	1	2	7	12	0	0	0
C10-A	4	0	3	2	5	12	0	0
D1	6	0	1	1	0	5	6	9
D3	3	2	7	7	6	0	0	0
F2	3	2	2	7	11	0	0	0
F5	3	0	1	4	17	0	0	0
F7	3	4	11	7	0	0	0	0
F1-A	4	3	7	6	5	1	0	0
F2	6	2	1	9	3	5	1	1
F4	4	1	7	6	6	2	0	0
G2	3	5	3	10	4	0	0	0
H1	6	0	1	4	5	3	5	4
I2	6	2	2	2	2	9	5	0
I4	3	3	3	8	8	0	0	0

APPENDIX B

BY STRAND AND TOTAL SCORE

1976 DELAWARE EDUCATIONAL ASSESSMENT PROGRAM

GRADE 4 MATHEMATICS

Wareded School District — Southeast Elementary — CLASSROOM NUMBER 01 — N = 22

STRAND	A	B	C	D	E	F	G	H	I	*
MAX SCORE	17	11	40	14	24	22	9	6	17	*
SCORE	FREQUENCY OF SCORE									*
40	0	0	0	0	0	0	0	0	0	*
39	0	0	1	0	0	0	0	0	0	
38	0	0	0	0	0	0	0	0	0	*
37	0	0	0	0	0	0	0	0	0	
36	0	0	1	0	0	0	0	0	0	*
35	0	0	0	0	0	0	0	0	0	
34	0	0	2	0	0	0	0	0	0	*
33	0	0	3	0	0	0	0	0	0	
32	0	0	1	0	0	0	0	0	0	*
31	0	0	1	0	0	0	0	0	0	
30	0	0	1	0	0	0	0	0	0	*
29	0	0	2	0	0	0	0	0	0	
28	0	0	2	0	0	0	0	0	0	*
27	0	0	1	0	0	0	0	0	0	
26	0	0	1	0	0	0	0	0	0	*
25	0	0	0	0	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	*
23	0	0	1	0	0	0	0	0	0	
22	0	0	1	0	0	0	0	0	0	*
21	0	0	1	0	0	0	0	0	0	
20	0	0	0	0	2	0	0	0	0	*
19	0	0	0	0	2	0	0	0	0	
18	0	0	0	0	1	2	0	0	0	*
17	1	0	1	0	1	0	0	0	0	
16	2	0	0	0	3	2	0	0	0	*
15	1	0	0	0	2	4	0	0	0	
14	0	0	0	1	3	1	0	0	2	*
13	0	0	1	2	2	1	0	0	1	
12	1	0	0	3	2	2	0	0	3	*
11	2	0	0	2	2	1	0	0	3	
10	1	2	1	3	0	2	0	0	3	*
9	2	3	0	3	2	1	1	0	1	
8	2	2	0	2	0	4	1	0	1	*
7	0	1	0	1	0	1	2	0	3	
6	3	3	0	0	0	1	1	1	0	*
5	1	1	0	2	0	0	1	5	1	
4	1	0	0	1	0	0	3	3	2	*
3	1	1	0	0	0	0	0	5	1	
2	0	0	0	0	0	0	2	4	0	*
1	0	0	0	0	0	0	2	1	1	
0	0	0	0	0	0	0	1	0	0	*

TOTAL RAW SCORE DISTRIBUTION

SCORE	FREQ	SCORE	FREQ	SCORE	FREQ	SCORE	FREQ
160	0	120	1	80	0	40	0
159	0	119	3	79	0	39	0
158	0	118	1	78	0	38	0
157	0	117	0	77	0	37	0
156	0	116	0	76	0	36	0
155	0	115	0	75	0	35	0
154	0	114	0	74	0	34	0
153	0	113	0	73	1	33	0
152	0	112	0	72	0	32	0
151	0	111	0	71	1	31	0
150	0	110	0	70	1	30	0
149	0	109	0	69	0	29	0
148	0	108	0	68	0	28	0
147	0	107	1	67	0	27	0
146	0	106	0	66	0	26	0
145	0	105	0	65	0	25	0
144	0	104	0	64	0	24	0
143	1	103	0	63	0	23	0
142	0	102	1	62	0	22	0
141	0	101	0	61	0	21	0
140	0	100	0	60	0	20	0
139	0	99	0	59	0	19	0
138	0	98	0	58	0	18	0
137	0	97	1	57	0	17	0
136	0	96	0	56	0	16	0
135	1	95	1	55	0	15	0
134	0	94	0	54	0	14	0
133	0	93	0	53	0	13	0
132	0	92	2	52	0	12	0
131	0	91	0	51	0	11	0
130	0	90	1	50	0	10	0
129	0	89	0	49	1	9	0
128	1	88	0	48	0	8	0
127	0	87	0	47	0	7	0
126	0	86	1	46	0	6	0
125	0	85	0	45	1	5	0
124	1	84	0	44	0	4	0
123	0	83	0	43	0	3	0
122	0	82	0	42	0	2	0
121	0	81	0	41	0	1	0
						0	0

APPENDIX C

ITEM RESPONSE BY OBJECTIVE REPORT

1976 DELAWARE EDUCATIONAL ASSESSMENT PROGRAM

GRADE 4 MATHEMATICS

Waredel School District N = 198

PERCENTAGE OF STUDENTS RESPONDING TO EACH ITEM CHOICE - LOCAL

ITEM	A	B	C	D	OMIT
A. NUMBERS/NUMERALS					
A1. IDENTIFY A FRACTION WHICH EXPRESSES PART OF A STANDARD GEOMETRIC SHAPE TO TENTHS.					
1	9	78 *	13	3	0
10	14	8	74 *	4	0
15	61 *	29	5	5	0
27	6	4	78 *	11	1
30	69 *	5	17	10	0
AVERAGE PERCENT CORRECT = 72					
A2. IDENTIFY THE COMMON AND/OR DIFFERENT ATTRIBUTES OF A GIVEN SET.					
1	7	12	64 *	16	1
7	1	9	90 *	1	0
9	2	90 *	4	4	0
14	15	65 *	10	10	0
26	72 *	2	10	15	1
32	24	39 *	15	19	3
AVERAGE PERCENT CORRECT = 70					
A3. IDENTIFY EVEN AND ODD WHOLE NUMBERS.					
3	11	14	61 *	15	0
23	3	80 *	12	3	2
29	20	60 *	7	5	0
AVERAGE PERCENT CORRECT = 67					
A4. ARRANGE A SET IN ORDER OF AT LEAST THREE UNIT FRACTIONS.					
35	39 *	7	5	46	4
38	60	22 *	7	7	4
40	6	63	20 *	7	4
AVERAGE PERCENT CORRECT = 27					

APPENDIX D